

Forest destruction in Indian hot spots: A threat to environment

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India has two biodiversity hot spot regions i.e. Eastern Himalayas and Western Ghats and is considered as one of the 12 mega diversity countries. In both the aforesaid areas the cause of forest destruction is different. In the E. Himalayas the native persons are directly dependent on the natural resources but in the W. Ghats commercialisation of the forest land area is the main cause of forest destruction. There is an urgent need to take it as a national agenda for conservation of our biodiversity hot spots.

Introduction

There is a stable resonance between biotic and abiotic factors for the successful establishment of an ecosystem but nowadays because of our immense need this resonance is destabilising and due to this our blue planet is facing many critical problems (Karl and Trenberth, 1999). Use of fossil-fuels and deforestation have increased the atmospheric carbon dioxide by 30% in the past three centuries and because of these green house gases (CO₂, CH₄, N₂O, CFCs and other trace gases) there is an imbalance in the Earth's energy budget (Hansen *et al.*, 2005). Humans have transformed 40-50% of the ice-free land surface, changed forests and wetlands into agricultural and urban system. The mobility of people has transported organisms across geographical barriers due to which many important plant and animal species of many areas have been introduced in the historic time (Vitousek *et al.*, 1997). There is already an extinction of 5-20% of the species in many groups of organisms and the current rate of extinction is estimated to be 100-1,000 times greater than pre-human rates (Pimm *et al.*, 1995; Lawton and May, 1995). An area is considered as hot spot when it contains endemic plant species comprising at least 0.5% of all plant species world-wide (Myers *et al.*, 2000). Higher biodiversity communities can consume more carbon dioxide and hence have high productivity (Naeem *et al.*, 1994) and reduce the chances of pest attack which decreases the host-specific diseases (Burdon, 1993), plant-feeding nematodes (Wasilewska, 1995) and consumption of preferred plant species (Bertness and Leonard, 1997) in an ecosystem. India is one of the 12th mega diversity countries and the total geographic area is 328.73 million ha which is 2.5% of the global land area having 1.8% of the global forest area (FSI, 1999). It is estimated that total forest cover of the country is 678,333 km² which is 20.64% of the geographic area of the country. Of about 1.7 million species globally described and recorded in the scientific literature, India has about 1,26,200 species (Khoshoo, 1995). As far as agro-biodiversity is concerned, India ranks seventh among the centres of diversity and origin of crop plants (Khoshoo, 1995). India possesses more than 45,000 plant species representing about 11% of the world biota so far described (Chowdhery & Murti, 2002) and has two hot spots namely Eastern Himalayas and Western Ghats. E. Himalayas mainly forms the states of Sikkim and Arunachal Pradesh whereas Western Ghats covers the parts of Goa, Maharashtra, Karnataka, Kerala and Tamil Nadu. The present study focuses on the forests of the Indian hot spots which are under heavy pressure of destruction due to man made activities. An attempt is also made regarding the future strategies for the development of these Indian hotspots so that the natural heritage can be preserved.

An intensive field survey was made in very interior of the forests of the Eastern Himalayas and the Western Ghats and information was collected by observation and formal interviews from local inhabitants. In the E. Himalayas author has done dendrochronology (Stokes and Smiley, 1968) in determining the age of the conifer trees in forests.

Himalaya

The Himalayan mountain ranges extend about 3000 km from west to east and are 240-400 km wide rising from the low-lying Indian plains to well over 8850 m. Situated between latitudes 27°-37°N & longitudes 73°-97° the E. Himalayas stretch across six nations namely Bhutan, China, India, Nepal, Pakistan and Afghanistan. In India, it covers Jammu and Kashmir, Himachal Pradesh, Uttarakhand, West Bengal, Sikkim and Arunachal Pradesh. About 4900 species of flowering plants are endemic to India; of which 2532 species are found in the Himalayan region (Paul et al., 2005).

Sikkim Himalaya:

Phytogeography: Sikkim is a small state with an area of 7096 km² extends between 27° 4' 46'' to 28° 7' 48'' N and 88° 58' 00' to 88° 55' 25'' E. Sikkim is a biodiversity rich state which contains 4000 flowering species including, 36 sps. of rhododendrons, 400 sps. of orchids, 1400 butterfly sps., 1200 moths, 550 birds, 144 mammals, 39 reptiles, 9 amphibians and 16 fish species (Rai & Sundriyal, 1997). Some important medicinal and commercial plants of Sikkim are *Abies densa* Griffith., *Aconitum heterophyllum* Wall. ex Royle, *Aegle marmelos* Correa ex Roxb., *Asparagus racemosus* Willd., *Berberis aristata* D.C., *Emblica officinalis* Gaertn., *Glycyrrhiza glabra* Linn., *Juniperus* spp. Linn., *Larix griffithiana* Carr., *Nardostachys jatamansi* D.C., *Ocimum sanctum* Linn., *Plantago ovata* Forsk., *Picrorhiza kurooa* Hook.f., *Piper longum* Linn., *Rauwalfia serpentina* Benth. ex Kurz, *Saussurea costus*, *Swertia chirayata* Roxb. ex Flem, *Tinospora cordifolia* Willd., *Lycopodium* spp. Linn., *Rhododendron fulgens* Hook.f. (rare), *Rhododendron maddenii* (rare), *Rhododendron pendulum* (rare) and *Rhododendron baileyi* (rare) etc.

Study sites: The main study sites in northern Sikkim are Lachung, Yumthang, Sevo, Lachen, Yakthang, Kalep and Thangu (Fig. 1 b & c). All these areas possess very dense forests of *Abies densa* Griffith, *Larix griffithiana* Carr. and *Juniperus* spp. Linn. whose age is in between 20-600 years. The tree line varies in between 3800-4200 m. a.s.l. which is quite higher than that of the western Himalayas due to high humidity.

Causes of deforestation:

1. Agriculture i.e. terrace cultivation is one of the major causes of destruction.
2. In Kalep, the bark of maximum old conifer trees is peeled off (Fig. 1a) and is used by the locals for their domestic and religious purposes.
3. The wood obtained from tall *Abies densa* Griffith trees is used for making long flag-posts.
4. Certain areas of Thangu and Yumthang have denuded mountains with stumps of very old conifer (*Juniperus* and *Abies densa*) trees as they were cut down by army for the defence purpose.
5. Wood obtained from *Abies densa* and *Juniperus* trees is used in making huts and home boundaries.
6. It is estimated that the hotel/lodge consumed about 60-70 kg of fuelwood (*Betula* spp., *Abies densa* etc.) per day, followed by 20-25 kg per day per family of 3-6 individuals and this rate increases during the winter season.
7. In terms of source of income people are mainly dependent on Himalayan tourism which also causes biodiversity loss.

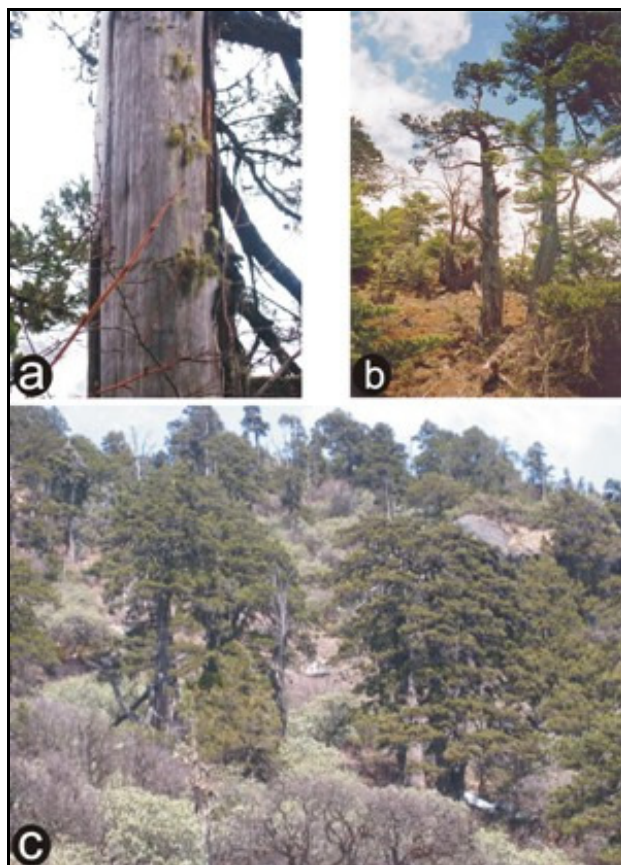


Fig. 1 : a. Bark of *Juniperus* tree is completely removed. b. Very old *Juniperus* and *Abies densa* trees in Thangu, Sikkim. c. *Juniperus* forest in Kalep, Sikkim.

Arunachal Himalayas:

Phytogeography: It is situated in the north-eastern part of India with 83,743 sq km area. It is situated between latitudes $26^{\circ} 30'$ and $29^{\circ} 30'$ and longitude $91^{\circ} 30'$ and $97^{\circ} 30'$. It is the largest state in the north-eastern part of India and is also among the 200 globally important ecoregions (Olson & Dinerstein, 1998). Forests of state contain important medicinal and commercial plant species like *Abies densa* Griffith, *Coptis teeta* Wall, *Fritillaria cirrhosa* D. Don, *Illicium griffithii* Hook.f. & Thoms., *Larix griffithiana* Carr., *Pinus merkusii* Jungh. & De Vriese, *Pinus wallichiana* A.B. Jackson, *Podophyllum hexandrum* Royle, *Panax* spp. Linn., *Rhododendron beanianum* Cowan (Rare), *Rhododendron boothii* Nutt. (Rare), *Rhododendron campylogynum* Franch. (Rare), *Taxus baccata* Linn, *Juniperus* spp. Linn. etc.

Study sites: The main study sites are Tawang, Se-La, Zemmithang, West Kameng and Itanagar.

Causes of deforestation:

Arunachal Pradesh displays different conditions in comparison to those of northern Sikkim.

1. Both terrace and shifting cultivations (Figure 2a) are prominent features of aforesaid areas.

2. Literacy rate is very low due to which there is a communication gap between the tribes and people of outer world and that is why they don't have awareness for the consequences of forest destruction.
3. Transportation of resources is very poor so they depend on natural resources.
4. Electricity is much limited; it affects the people in various ways like communication, lighting and other appliances which consume electricity.
5. Minimal use of funds in development of interior areas of mountains.
6. In Se La stumps of *Abies densa* Griffith trees can be seen very frequently near Jaswantgarh as they were cut down by army for the defence purpose.
7. Man made forest fire is very frequent in the *Abies densa* Griffith forest in Tawang.
8. The average fuelwood (*Pinus* spp.) consumption as primary source of energy is about 6 kg/day/person.



Fig. 2 : a. Photograph showing shifting cultivation in Arunachal Pradesh. b. Photograph showing the two *Juniperus* tree stumps and author is doing coring in *Juniperus* tree for determination of tree age by counting annual rings.



Fig. 3: Photographs showing *Camellia sinensis* (L.) Kuntze plantation and barren forest land in Munnar.

Western Ghats:

Phytogeography: The Western Ghats is a mountain range in the west of peninsular India. The range starts near the border of Gujarat and Maharashtra, south of the Tapti River and runs approximately 1600 km through the states of Maharashtra, Goa, Karnataka, Tamil Nadu and Kerala ending at Kanyakumari, at the southern tip of the Indian peninsula. Some of the endemic plants of W. Ghats are *Anacolosia densiflora* Bedd., *Artocarpus heterophyllus* Lam., *Bulbophyllum acutiflorum* A. Rich (Rare), *Bulbophyllum tremulum* Wt., *Calamus huegelianus* Mart. (Rare), *Calamus rheedii* Griff. (Rare), *Dendrobium nanum* Hook.f., *Diplozentrum congestum* Wt., *Dipterocarpus bourdillonii* Brandis, *Garcinia indica* Choisy, *Gordonia obtuse* Wall., *Hydnocarpus laurifolia* (Dennst.) Sleumer, *Heritiera papilio* Bedd. *Holigarna arnotiana* Hook. f., *Humboldtia vahliana* Wight, *Memecylon malabaricum* Cogn., *Myristica malabarica* Lam., *Oberonia*

bisaccata Manilal, *Palaquium ellipticum* (Dalz.) Baill., *Polyalthia fragrans* Bedd. and *Vateria indica* Linn. etc.

Study area: It mainly includes the Munnar (10° 9' 1.7" N & 77° 4' 54.8" E) of the Idduki District in Kerala.

Causes of deforestation: Commercialization of forest land area *i.e.* mainly the *Camellia sinensis* (L.) Kuntze (Figure 3) plantation over the huge forest area is the main cause and up to some extent cultivation of *Coffea arabica* L., *Elettaria cardamomum* Maton, *Theobroma cacao* L., *Syzygium aromaticum* (L.) Merrill & Perry and *Piper nigrum* L. is also causing forest destruction. Secondly, role of tourism cannot be ignored in the area for destruction.

Consequences of forest destruction: Forest destruction in Northern Sikkim Himalayas causes the removal of very old conifer trees (Figure 4) which are in climax stage while in Arunachal Pradesh Himalayas in Tawang and West Kameng areas it causes threatening of many plant species like *Monotropastrum humile* (D. Don) H. Hara, *Podophyllum hexandrum* Royle, *Berginea ciliate* Sternb., *Saussurea obvallata* Wall. ex C.B. Clarke, *Saussurea gossypifora* D. Don, *Rheum nobile* Hook. f. & Thoms., *Panax pseudo-ginseng* Wall., *Illicium griffithii* Hook. f. & Thoms., *Rhododendron kendrickii* Nutt. and *Narvelia zeylanica* DC. etc. In the Western Ghats, commercialization of the forest land is changing the heterogeneity of the local flora into the homogeneity and thus the species loss is going on.

Discussion

Deforestation in temperature limited environment like Himalayas is increasing the temperature of the region which can be easily seen in the W. Himalaya where upward shift of the Himalayan pine has already been recorded (Dubey *et al.*, 2003). Arunachal Pradesh has a total of 13 protected areas including national parks and wildlife sanctuaries which only cover 12.03% of the land area of the state (Kutty and Kathari, 2001) but the protected areas largely cover the low and mid-elevation forests. This is despite the fact that 23% of the area of the state is above 3000 m (Mishra *et al.*, 2004). In the W. Ghats according to an estimate 0.90% is annual decline in natural forest cover in Kerala for the period 1961-1988 (Prashad *et al.*, 1998). If we talk on the consequences of deforestation in the tropical region like the Western Ghats, we can compare the results from the Amazonian deforestation where the significant increase in surface temperature and a decrease in evapotranspiration and precipitation over Amazonia was recorded (Shukla *et al.*, 1990). The International Man & Biosphere Programme (MAB) was started in 1971 and about 110 countries co-ordinated in the MAB. In India, 13 ecosystems have been identified to be protected as Biosphere Reserves, including the Nilgiri Biosphere Reserve in the Western Ghats which covers an area of 5520 sq km which is very less as compared to the total geographical area in the Western Ghats which is about 1, 37,187 sq km. (Tiwari, 1995).

Conclusion

Many studies indicate the importance of the Himalayan climate in regulating the monsoon dynamics of not only the Indian subcontinent, but also the Southeast Asia (Prell and Kutzbach, 1992; Yang, 1996; Gupta and Anderson, 2005). If we have a close look on Figure 4 it can be observed that very old conifer forests are still present in W. Himalayas but in E. Himalayas old trees are very rare due to heavy deforestation. The following are some blue prints for conserving biodiversity in the Indian Hot spots:

1. Many of the species in the Indian hot spots are still unidentified. So in order to identify all those species, an international collaboration must be done with expert taxonomists this needs a relaxation in Indian Biodiversity Act (Prathapan *et al.*, 2006).

Table- 4. Table showing the age of conifer trees, modified from Bhattacharya *et al.*, 1999.

S.No.	Name of the species	Distribution	Probable age
1.	<i>Abies densa</i>	E. Nepal, Sikkim (Lachung, Lachen, Sevo, Yakthang, Yumthang, Kalep and Thangu), Darjeeling to Arunachal Pradesh at 2750-3950 m.	Probably over 491
2.	<i>A. pindrow</i>	Afghanistan, Pakistan Himalaya-Nepal (W. Himalaya-Nepal) at 2300-3350 m.	360
3.	<i>A. spectabilis</i>	All along the Himalayas from Pakistan-Arunachal Pradesh, Tibet at 2800-4300 m. Commonly between 3300-4000 m.	370
4.	<i>Cedrus deodara</i>	Afghanistan, Kashmir Himalaya, Garhwal, Kurnauli Valley (W. Nepal) at 1200-3300 m.	1200
5.	<i>Juniperus macropoda</i>	Afghanistan, Baluchistan, Kagan Valley, Kashmir, Lahul to over 1200 m Kumaon, W. Tibet, 2500-4300 m.	1200
6.	<i>J. wallichiana</i>	All along the Himalayas from Indus to Sikkim, Bhutan and W. Tibet.	170
7.	<i>Larix griffithiana</i>	E. Nepal, Sikkim (Yakthang), Arunachal Pradesh.	250
8.	<i>Pinus roxburghii</i>	All along the Himalayas from Pakistan to Arunachal Pradesh at 450-2300 m except the Kashmir valley.	327
9.	<i>Pinus wallichiana</i>	All along the Himalayas from Pakistan- Arunachal Pradesh at 1800-3700 m; rare in Sikkim.	275
10.	<i>Taxus baccata</i>	All along the Himalayas from Pakistan-Arunachal Pradesh.	1000

2. More protected areas are needed and their employees should be the native of there because they have better knowledge of the flora and fauna of that area and due to this they would also get priority in the employment.
3. The scientists and learned citizens should collaborate with the government organisations in making and implementing forest & biodiversity policies and regulation.
4. The scientific community should be engaged to convince the general public, policy-makers and land managers about the effect of irreversible loss of biodiversity.
5. Media will have to play a major role in filling the communication gap between the mountainous people and people of the outer world.
6. Maximum use of fund in the development of anterior areas of mountain is needed.
7. There should be some national organisation which could assess the changes in biodiversity and their consequences.
8. More taxonomists are needed for the correct identification of the species.

In order to conserve the Indian Hot Spots, there is need to adopt it as a national agenda because biodiversity is a non-renewable resource and if it is not conserved, the Indian hot spots will become cold spots and result in losing their identity in near future at the global level.

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Suggested readings:

- Anon., 2000 State of Forest Report 1999, Forest Survey of India, Ministry of Environment & Forest, Dehra Dun.
- Bertness, M.D. and Leonard, G.H. (1997) The role of positive interactions in communities: Lessons from intertidal habitats. *Ecology*, v. 78, pp. 1976-1989.
- Bhattacharya, A., Yadav, R.R. and Chaudhary, V. (1997) The Himalayan Conifers and their perspectives in Dendroclimatic studies. *Himalayan geology*, v.18, pp. 169-176.
- Burdon, J.J. (1993) The structure of pathogen populations in natural plant communities. *Annu. Rev. Phytopathol.*, v. 31, pp. 305-323.
- Chowdhery, H.J. and Murti, S.K. (2002) Plant diversity and conservation in India. An overview. Bishen Singh and Mahendra Pal Singh, Dehra Dun.
- Dubey, B., Yadav, R.R., Singh, J., and Chaturvedi, R. (2003) Upward shift of Himalayan pine in Western Himalaya, India. *Curr. Sci.*, v. 85 (8), pp. 1135-1136.
- Forest Survey of India, State of Forest Report 1997, Ministry of Environment and Forests, Government of India, Dehra Dun, 1997.
- Forest Survey of India, State of Forest Report 1999, Ministry of Environment and Forests, Government of India, Dehra Dun, 1999.
- Gupta, A.K. and Anderson, D.M. (2005) Mysteries of the Indian Ocean Monsoon system. *Jour. Geol. Soc. India*, v. 65, pp. 54-60.
- Hansen, J., Nazarenko, L., Ruedy, R., Sato, M., Willis, J., Genio, A.D., Koch, D., Lacis, A., Lo, K., Menon, S., Novakov, T., Perlwitz, J., Russell, G., Schmidt, G.A. and Tausnev, N. (2005) Earth's Energy Imbalance: Confirmation and Implications. *Science*, v. 308, pp. 1431-1435.
- Karl, Thomas R. and Trenberth, E. (1999) The human impact on climate. *Scientific American*. Dec. pp. 100-105.
- Khoshoo, T. N. (1995) Census of India's biodiversity: Tasks ahead. *Curr. Sci.*, v. 69, pp. 14-17.
- Kutty, R. and Kathari, A. (2001) Protected Areas in India- A profile. Kalpavriksh, Deccan Gymkhana. Pune, p. 157.
- Lawton, J.H. and May, R.M. (1995) *Extinction Rates*. Oxford University Press, Oxford.
- Mishra, C., Datta, A. and Madhusudan, M.D. (2004) The high altitude wildlife of Western Arunachal Pradesh. A survey report. CERT Tech. Rep., 8, pp. 33-38.
- Myers, N., Mittermeier, Russell A., Mittermeier Cristina G., da Fonseca Gustavo A.B. and Kent, J. (2000) Biodiversity hot spot for conservation priorities. *Nature*, v. 403, pp. 853-858.
- Naeem, S., Thompson, L.J., Lawler, S. P., Lawton, J. H., and Woodfin, R.M. (1994) Declining biodiversity can alter the performance of ecosystem. *Nature*, v. 368, pp. 734-737.
- Olson, D. M. and Dinerstein, E. (1998) The global 200: A representation approach to conserving the earth's most biologically valuable ecoregions. *Conserv. Biol.*, v. 12, pp. 502-515.
- Paul, A., Khan, M. L., Arunachalam, A. and Arunachalam, K. (2005) Biodiversity and conservation of rhododendrons in Arunachal Pradesh in the Indo-Burma biodiversity hotspot. *Current Science*, v. 89, 623-634.
- Pimm, S.L., Russell, G.J., Gittleman, J.L. and Brooks, T.M. (1995) The future of biodiversity. *Science*, v. 269, 347-350.
- Prasad, S. Narendra, vijayan, L., Balachandran, S., Ramachandran, V.S., and Verghese,C.P.A. (1998) Conservation Planning for the Western Ghats of Kerala: I. A GIS approach for location of biodiversity hot spots. *Curr. Sci.*, v. 75 (3), pp. 211-219.
- Prathapan, K.D., Rajan, Priyadarsanan Dharma, Narendran, T.C., Viraktamath, C.A., Subramanian, K.A., Aravind, N.A. and Poorani, J. (2006) Biological Diversity Act, 2002: Shadow of permit-raj over research, *Curr. Sci.*, v. 91 (8), pp. 1006-1007.
- Prell, W.L. and Kutzbach, J.E. (1992) Sensitivity of the Indian monsoon to forcing parameters and implications for its evolution. *Nature*, v. 360, pp. 647-652.
- Rai, S.C. and Sundriyal, R.C. (1997) Tourism and biodiversity conservation: The Sikkim Himalaya, *Ambio*, v. 26 (4), pp. 235-242.
- Shukla, J., Nobre, C. and Sellers, P. (1990) Amazon Deforestation and Climate Change. *Science*, v. 247, pp. 1322-1325.
- Stokes, M. A. and Smiley, T. L. (1968) *An Introduction to Tree-Ring Dating*. University of Chicago Press, Chicago.
- Tiwari, D.N. (1995) *Western Ghats Ecosystem*. International Book Distributors, Dehra Dun. p-19.
- Vitousek, P.M., Mooney, H.A., Lubchenco, J. and Melillo, J.M. (1997) Human domination of Earth's ecosystems. *Science*, v. 277, pp. 494-499.

Wasilewska, L. (1995) Differences in development of soil nematode communities in single- and multi-species grass experimental treatments. *Appl. Soil Ecol.*, v. 2, pp. 53-64.
Yang, S. (1996) Snow-monsoon associations and seasonal-interannual prediction. *Intl. Jour. Clim.*, v.16, pp. 125-134.

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